Role for Damage Control Orthopaedics in Natural Disaster like Earthquake

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ABSTRACT

Introduction: The **April 2015 Nepal earthquake** killed more than 9,000 people and injured more than 25,000. It was one of the most catastrophic natural disasters in the history of Nepal. The massive morbidity arising out of this event, a significant number of these patients had sustained polytrauma. In such situations the principle of Damage Control Orthopaedics (DCO) may be used. The objective of this study is to study the efficacy of damage control orthopaedics, in a mass disaster like earthquake.

Material and methods: It was a retrospective study with 228 wounded patients with polytrauma done in Nepal Medical College and Teaching Hospital after the earthquake. The specific techniques employed for damage-control was with external fixation.

Results: Out of the 228 wounded people, external fixators were applied to 41(17.98%) patients sustaining the open long bone fractures and all femur fractures.

Conclusion: Application of damage control orthopaedics in mass disasters may be recommended with External fixators as a valuable damage-control tools in natural disasters.

Keywords: Earthquake, polytrauma Damage Control Orthopaedics, External Fixator

INTRODUCTION

The **April 2015 Nepal earthquake** killed more than 9,000 people and injured more than 25,000.[1] The earthquake occurred on 25th April 2015 at 11:56 a.m. NST at a depth of approximately 15 km (9.3 mi) with its epicentre approximately 34 km (21 mi) east-southeast of Lamjung, Nepal, lasting approximately fifty seconds.[2] A major aftershock of magnitude 6.7 M^w occurred on 26th April 2015 in the same region at 12:55 NST, with an epicenter located about 17 km (11 miles) south of Kodari, Nepal.[3] A second major earthquake occurred on 12th May 2015 at 12:51 NST with a moment magnitude of 7.3 M^w 18 km (11 miles) southeast of Kodari. The epicenter was near the Chinese border between the capital of Kathmandu and Mt. Everest. As such, it is considered to be an aftershock of the 25th April quake.[4]

Till 2nd September 2015, 386 aftershocks had occurred with different epicentres and magnitudes equal to or above 4 M^w (out of which 51 aftershocks are equal to or above 5 M^w) and more than 20,000 aftershocks less than 4 M^w .[1]

The tremors and constant landslides multiplied the shock and trauma, while the onslaught of a heavy raining jeopardised the lives of survivors. It was one of the most catastrophic natural disasters in the history of Nepal. The earthquake created a massive managerial task to aid the injured, from triage to rehabilitation.[5] Beyond the magnitude of the disaster, the uniqueness of this earthquake was that many local health services centre were demolished: some were physically destroyed while others were sufficiently disabled as to be non-functional because of secondary earthquake issues like road blocks, electricity outage etc. Then immediately health services centre were re-establish within the open spaces of the larger hospitals. The massive morbidity arising out of this event, a significant number of these patients had sustained polytrauma with involvement of multiple systems, in addition to long bone and pelvic fractures, among which most of them were open injury.

The principles of fracture management in poly-trauma patients with open injury continue to be of crucial importance. In such situations the principle of Damage Control Orthopaedics (DCO) may be used. The term Damage Control Orthopaedics (DCO) was initially described by the US navy as "The capacity of the ship to absorb damage and maintain mission integrity".[6] In medicine, this term was first used by general surgeons to describe immediate life-saving procedures to control haemorrhage and minimise lengthy definitive procedures that may be deleterious to patients following such trauma.

The term DCO was first used by Scalea *et al*. to describe a similar approach to musculoskeletal injuries[7].

The main tool in the DCO is external fixator, its role has been well described. This provides bone stabilization in conjunction with soft tissue care while avoiding deterioration of the patient's physiologic condition as a result of either prolonged surgery or embolic phenomena related to the immediate definitive fixation of long-bone fractures.[8]

The objective of this study is to study the efficacy of damage control orthopaedics, in a mass disaster where enormous patient loads are encountered and hospital resources are stretched to the limit.

MATERIAL AND METHODS

It was a retrospective study with 228 wounded patients with injuries to the extremities and multiple injuries to the abdomen, thorax and head, who received primary surgical treatment at Nepal medical college teaching hospital, after the earthquake.

The tent was set over the open spaces of the hospital premises at the triage area after few hours of earthquake for the splintage. The next morning another tent was set up under sterile conditions for the surgery.

Patients were first seen and evaluated in the Triage unit. They were then redirected to orthopaedic tents. Radiographs and blood tests were performed as needed. The patients were managed according to the principles of damaged control orthopaedics.

The specific techniques employed for damage-control was with external fixation in the earthquake - The general principles, however, remain the same. First and foremost, standard external fixation principles were applied, like optimising fracture reduction, cortical contact and increasing pin diameter to increase stability of the construct based on preoperative X-ray findings and intraoperative palpation. Fracture alignment of closed fractures was performed by manual traction and open fractures were aligned by visual repositioning. Schanz pins insertion into long bones was based on established surgical approaches for the application of external fixators. There was no attempt to achieve optimal reduction but to align, stabilize and achieve satisfactory length thereby facilitating soft tissue care, reducing pain and enabling early mobilization (Fig.1).

RESULTS

Out of the 228 wounded people, 102 (44.7%) were men, 86 (37.7%) were women and 40 (17.6%) were children. The patients were in between the age group of 6 to 85 years with an average age of 34.7 years. The maximum number of injuries were seen in lower limb, which were 121 (53.07) patients, out of which 98 (80.99%) had tibial fracture and 23(19.01%) had femur fracture. The upper limb, pelvis and spine injury were seen in 36 (15.78%), 28(12.28%) and 22(9.64%) patients respectively. The head injury was seen in 14 (6.14%) patients whereas least 7 (3.07%) patients had abdomen injury. (Table No.1).

Table 1: Distribution of injured Extremities

Injured Extremities		No. of Patients	Percentage
Lower Limb	Tibia	98	80.99
	Femur	23	19.01
Upper Limb		36	15.78
Pelvis		28	12.28
Spine		22	9.64
Abdomen		7	3.07

The primary treatment for muscular and skin injuries by conservative means was 164 (71.92 %) patients, external fixator were applied to 41(17.98%) patients sustaining the open long bone fractures and all femur fractures, Solid intramedullary nailing was done in 22 (9.64%) patients those who sustained a tibial fractures and 1(0.43%) patients who had severe crush injury of the lower extremity (Below Knee) were amputated as it was a nonviable and life threateninglimb infection.

The external fixator applied according to the anatomical site of the fracture, 32 (78.04%) in lower limbs, 23(71.8%) were tibial and 9(28.2) femoral. Total fixators applied on upper limbs were 4(9.76), where 1(25%) on the Humerus and 3(75%) around the forearm and hand. The fixators applied in pelvis were 5(12.2%) (Fig.2).

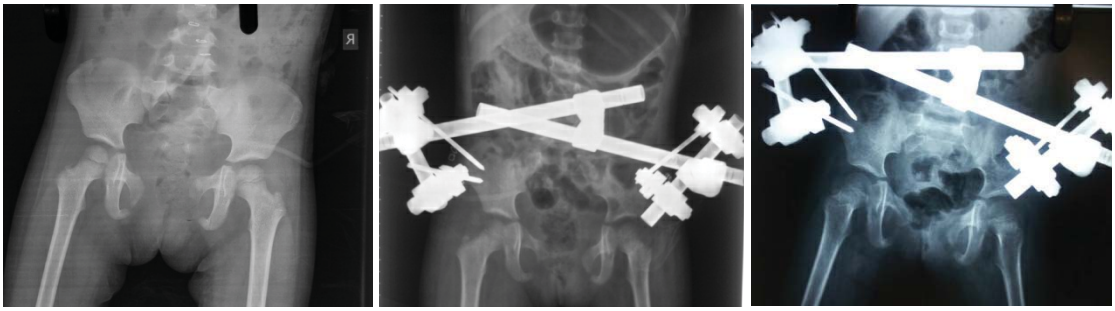

Figure 1: External Fixator applied in Pelvis

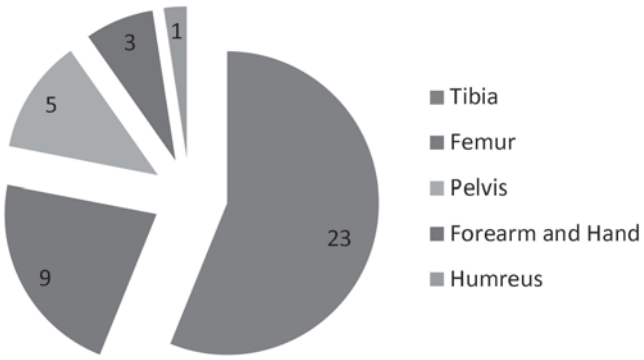

Fig 2: External Fixator applied according to the Injured Site

The patients were discharged with the advise for pin tract care, antibiotic treatment (where indicated). There was pin tract infection in 5 (12.20%) patients, which was resolved with regular dressing and antibiotics during the regular follow up.

The Fixators were used as definitive treatment for particular fractures, with successful outcomes regarding bony union and wound healing. Most patients were lost to follow – up, so exact results could not be properly evaluated and documented.

DISCUSSION

Earthquakes are one of the mostcatastrophic natural disasters[9]. In the disaster scenario like earthquake, the fracture management in polytrauma patients continue to be of crucial importance. Over the last 5 decades various strategies of fracture treatment in the multiply injured have been evolved.[10]The fracture care in polytrauma cases in mass disasters is complicated further by the occurrence of crush syndrome, renal failure, contamination and neurovascular compromise[11].

The concept of total care (ETC) developed in the 80s with O' Brien *et al* stating that in a majority of cases of long bone fracture, interlocking, intramedullary nailing can be done. Recently however application of early total care has been reported as not being beneficial to all the patients, with adverse outcome being encountered in poly traumapatients[10]. The application of early total care in cases with co existing chest injuries, head trauma and those with mangles extremities may be potentially harmful[12]. There is also evidence that an increased complication rate may be encountered in such cases[13,14].

The principle of Damage Control orthopaedics (DCO) was used for the first time by Orthopaedic Surgeons from R. Adams Cowley Shock Trauma Center[15]. Damage control orthopaedics in such situations may provide additional advantage by preventing the occurrence of second hit that might manifest in terms of better overall care of patients.

An external fixation is a prime modality for the application of damage control Orthopaedics providing the following advantages like decreased operating time, blood loss and local complications. The most importantly allows good wound care and physiotherapy.

CONCLUSION

The majority of survivors injured in the earthquake of Nepal 2015, who were admitted to the hospital required surgical treatment of extremity injuries, which were managed according to the DCO. External fixators are valuable damage-control tools in natural disasters.

Application of damage control orthopaedics in mass disasters may be recommended, which have significant ramifications in such situations.

This study is limited by the lack of a comparative study conducted elsewhere in similar circumstances

REFERENCES

1. National Seismological Centre, Nepal. "Aftershocks of Gorkha Earthquake"', *National Seismological Centre, Nepal.* Undefined:.
2. National Geographic. "Nepal Earthquake Strikes One of Earth's Most Quake-Prone Areas"', *National Geographic.* Undefined: Retrieved 27 April 2015.
3. USA Today. "Nepal hit by major aftershock as search for quake survivors intensifies"', *USA Today.* Undefined: Retrieved 26 April 2015.
4. USGS Earthquake Hazards Program. "M7.3 - 18km SE of Kodari, Nepal"', *USGS Earthquake Hazards Program.* Undefined:.
5. Yasin MA, Malik SA, Nasreen G, Safdar CA. Experience with mass casualties in a subcontinent earthquake. *Ulus TravmaAcilCerrahiDerg* 2009; 15: 487–92.
6. Pape H-C, Hildebrand F, Pertschy S, Zelle B, Garapati R, Grimme K, Krettek C . Changes in the management of femoral shaft fractures in polytrauma patients: From early total care to damage control orthopedic surgery. *J Trauma-Injury Infect Crit Care* 2002; 53: 452–62.
7. Scalea TM, Boswell SA, Scott JD, Mitchell KA, Kramer ME, Pollak AN. External fixation as a bridge to intramedullary nailing for patients with multiple injuries and with femur fractures: Damage control orthopedics. *J Trauma* 2000; 48: 613–21.
8. Tuttle MS, Smith WR, Williams AE, Agudelo JF, Hartshorn CJ, Moore EE, Morgan SJ . Safety and efficacy of damage control external fixation versus early definitive stabilization for femoral shaft

fractures in the multiple-injured patient. *J Trauma Acute Care Surg* 2009; 67: 602–5.

9. Lu-Ping Z, Rodriguez-Llanes JM, Qi W, van den Oever B, Westman L, Albela M, *et al*. Multiple injuries after earthquakes: a retrospective analysis on 1,871 injured patients from the Wenchuan earthquake. *Crit Care.* 2012; 16: R87.
10. Hildebrand F, Giannoudis P, Kretteck C, Pape HC. Damage Control: Extremities. *Injury* 2004; 35: 678-9.
11. Tahmasebi MN, Kiani K, Mazlouman SJ, Taheri A, Kamrani RS, Panjavi B, Harandi BA. Musculoskeletal injuries associated with earthquake, a report of injuries of Iran's December 26, 2003 Bam earthquake casualties managed in tertiary referral centres. *Injury* 2005; 36: 27-32.
12. Roberts CS, Pape HC, Jones AL, Malkani AL, Rodriguez JL, Giannoudis PV. Damage Control Orthopaedics: Evolving concepts in the treatment of patients who have sustained orthopaedic trauma. *Instr Course Lect* 2005; 54: 447-62.
13. Gustilo RB, Anderson JT. Prevention of infection in the treatment of one thousand and seventy five open fractures of long bones: retrospective and prospective analyses. *JBJS* 1976; 58: 453.
14. Pape HC, Auf'm'Kolk M, Paffrath T, Regel G, Sturm JA, Tscherne H. Primary intramedullary femur fixation in multiple trauma patients with associated lung contusion – a cause of post traumatic ARDS ?. *J trauma* 1993; 34: 540-7.
15. Pape HC. : Immediate fracture fixation – which method? Comments on the John Border memorial lecture. *Ottawa* 2005.